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COMPLETE SPECIFICATION

Abrasive Devices

We, REXALL DRUG AND CHEMICAL COMPANY, a Corporation organised under the Laws of the State of Delaware, United States of America, of 8480, Beverly Boulevard, Los Angeles, in the County of Los Angeles and State of California, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

THIS INVENTION relates to the art of abrading and polishing and particularly to a complete line of abrasive devices for performing many of the abrading, polishing and buffing operations well known in that art. It especially pertains to various forms of abrasive devices such as abrasive belts, discs, wheels, pads, drums or the like embodying a suitable supporting structure in the form of a hub, core or backing member to which is secured a plurality of individually and collectively acting abrasive elements.

Many abrasive operations involve dressing, restoring, polishing, buffing, finishing, or otherwise altering the surfaces of innumerable articles of manufacture, and especially articles of irregular contour, in which little or no stock removal is frequently desired, but the primary objective is the thorough, and uniform treatment of the entire surface of the workpiece, irrespective of the amount of material to be removed. Rigid bonded abrasive articles of the conventional grinding wheel type have never been particularly well adapted for such purposes because of the inability of such articles to follow the contour of the workpiece except in the case of articles having planar surfaces. Consequently, other means have been employed heretofore for carrying out many of the various surfacing operations demanded by industry. For example, despite the almost complete lack of control over the regularity and evenness of

action and the inordinately low level of performance obtained from the individual abrasive particles through their instantaneous impact with the workpiece, sandblasting has been used in which a loose abrasive material is forcefully impinged against the surface of the article to be polished or otherwise dressed. Wire brush devices have also been used to scratch the surface of the article to give the desired surface finish. While sandblasting and wire brushing operations are more or less uncontrollable and irregular in performance, they have the advantage of offering no loading problem.

Fabric buffing wheels in conjunction with loose abrasive materials have been used for many polishing operations. Likewise, abrasive coated materials such as abrasive-coated paper and cloth products, supported by contoured or yieldable backing means, have been used to perform many of the abrasive and polishing operations on articles of irregular surface contour. All these devices have required frequent replacement of the abrasive materials or elements, have been irregular or uneven in their application and action on the entire surface of the workpiece, have frequently presented loading problems, and for these and other reasons have not been entirely satisfactory.

Furthermore, in all those techniques very inefficient use has been made of the particular abrasive element which has been discarded without obtaining the benefit of its full potential of usefulness.

The present invention is founded upon a fundamentally novel concept of providing an abrasive article in which the abrasive material whether particulate or filamentary in character, is not only forcibly presented to the surface of the work, regardless of the irregularities of the workpiece surface, with all the forcefulness of a sandblasting operation, but with far greater uniformity of action over

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the area of the workpiece. Furthermore, the abrasive material of the abrasive article is subject to a controlled action and restrained against premature release from its supporting background by being adjustably secured in a more or less resilient matrix without being rigidly anchored in permanently fixed position in a hardened bonding medium, whereby the individual abrasive particles or filaments of the abrasive material are repeatedly presented to the work-piece from the new positions. As a result of this controlled positional freedom of movement of the abrasive material in abrasive articles of the present invention the abrasive material is utilized effectively to a far greater extent than has heretofore been accomplished with articles in which the abrasive material has been rigidly fixed or anchored in its bonding medium. Despite the numerous ramifications of the present invention as manifested in the different embodiments described later herein, it is to be noted that these fundamental, novel concepts are structurally designed into the product in all its forms. The abrasive articles of the present invention are characterized to a marked extent by the following combination of desirable and long sought-for functional properties:

- (a) Non-loading, free-cutting character.
- (b) Coolness of cutting action.
- (c) Thorough utilization of the abrasive material.
- (d) Uniformity of abrasive action on both plane and irregular surfaces of work-pieces.
- (e) Smoothness of operation.
- (f) Efficiency of performance.
- (g) Extraordinarily long life of the abrasive product.

An object of the present invention is to provide an improved form of abrasive device.

According to the present invention there is provided an abrasive device comprising a shirred abrasive strip material mounted upon a support or backing, said shirred abrasive strip material being adhesively secured to the backing along alternate fold lines of the shirred strip material with the individual shirrs thereof at least partially overlapping one another in the direction of movement of the device during use and forming a plurality of separate abrading elements constituting the working face of the abrasive device.

Where reference is made herein and in the claims to a shirred material or to the shirrs thereof it is intended to mean and cover a material which has been shirred or pleated to form a folded material in which the pleats or shirrs are pulled or brought together and held in the desired folded or pleated relationship either by a draw string or strings and/or held against pulling apart beyond the desired amount by securing eg. by adhesively tacking or bonding, the shirrs or pleats to their backing or other supporting

structure in the desired conformed position.

The abrasive strip or sheet material embodied in the article can be so shirred that the individual shirrs either fully or partially overlap one another, depending upon the specific type and form of abrasive device desired. Also, the individual shirrs making up the functional face or faces of the article can be closely adjacent one another or they can be individually spaced or separated one from the other to produce an open faced working structure, depending upon the particular type of product to be made and the specific use for which it is intended. The shirred abrasive material is desirably a material which is abrasive and functionally expendable throughout its thickness, although this does not exclude the use of shirred abrasive materials which are reinforced by filamentary, fibrous or fabric reinforcing means, providing the latter is not such that will interfere with the uniform cutting action and breakdown of the shirred material in use. Highly satisfactory results have been obtained in the making of abrasive belts, discs and buffing wheels in accordance with the present invention utilizing as the shirred abrasive material an abrasive-included fibrous sheet material such as that disclosed and described in our British Patent Specification No. 557,038. Such abrasive-included fibrous sheet material can be used alone or in combination with abrasive-coated fabrics or layers of matted steel wool or other filamentary or fibrous abrasive materials. Such abrasive-included fibrous sheet material can be described as a non-lamellar web structure of individual cardable interlocked textile fibres, adhesive binder and abrasive granules which are distributed internally of and throughout the fibrous web and are secured in the web by being surrounded by the long fibres. Although the uppermost granules penetrate through and above the surface of the web, they are also securely attached by the surrounding fibres, which with the aid of the adhesive binder secures them in position.

Such an abrasive-included fibrous sheet material, either alone or combined with other materials, when shirred and secured to a suitable backing or support to form an abrasive device in accordance with the teachings herein, provides an abrasive device embodying the principles of the present invention in that the functional or abrading component of the device is of substantial depth and therefore of relatively long life, is expendable throughout, allows readjustment of abrasive grain positions in use without premature release of the abrasive particles, and at the same time is yieldable and conformable to irregularities in the surface of a work piece presented to the device.

However, it is not intended that the present invention should be limited to the use of

any specific abrasive substance in the abrasive-included fibrous sheet material referred to above. Any of the particulate abrasive materials in common use may be employed in practising the present invention. Such materials include silicon carbide, fused aluminium oxide, natural corundum, emery, rouge, tripoli, and similar substances. The size of the abrasive may vary from the finest polishing or buffing powders to the coarser grit sizes used in grinding.

Other granular, fibrous or filamentary materials suitable for various abrasive or polishing purposes and which can be embodied in the form of a shirred strip of sheet material of any desired width can be similarly utilized to carry out the present invention. For example, steel wool can be laid down in the form of a layer or sheet of intertangled steel wool fibres and the resulting sheet or strip of steel wool shirred and the shirred material secured to a backing to form an abrasive device in accordance with the practices laid down herein. When steel wool or other fibrous or filamentary material is used as the abrasive substance and is fabricated into a shirred sheet or strip it is usually desirable to impregnate or treat the fibrous layer with a resilient binder such as a rubber latex to hold it in suitably compressed form.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is an elevational view of an endless abrasive belt made in accordance with the present invention;

Figure 2 is a top plan view of a fragment of the abrasive belt shown in Figure 1, the left hand portion showing the fold lines of the shirred material before the material has been folded;

Figure 3 is a highly enlarged vertical section through the line 3—3 of Figure 2 the unfolded left hand portion not being included.

Figure 4 is a view similar to that of Figure 3 showing a modified form of abrasive belt made in accordance with the present invention;

Figure 5 is a top plan view of a fragment of an abrasive belt embodying further modifications of the present invention, the left hand portion again depicting the disposition of the transverse fold lines of the material prior to their being shirred;

Figure 6 is a top plan view of an abrasive disc embodying principles of the present invention;

Figure 7 is a vertical diametrical sectional view through the lines 7—7 of Figure 6;

Figure 8 is a highly enlarged vertical section, similar to the views of Figures 3 and 4, showing still another modification of the present invention;

Figure 9 is a side elevational view of a polishing wheel embodying the principles of the present invention;

Figure 10 is a frontal view of the wheel shown in Figure 9 and;

Figure 11 is a fragmentary plan view of the back side of an abrasive belt, showing the filamentary reinforcing means thereof.

Figures 1, 2 and 3 depict one embodiment of the present invention in the form of an endless abrasive belt comprising a flexible fabric backing member 15, to which is adhesively secured by means of a layer of adhesive 16 a shirred abrasive sheet material 17. Using a fibrous abrasive-containing sheet material such as that disclosed and described in British Patent Specification No. 557,038, there have been made abrasive belts of the type shown in Figures 1, 2 and 3, as for example an abrasive belt 4" wide and 54" long as follows.

A long continuous 4" wide strip of abrasive-included fibrous sheet material 17 is first folded transversely of the strip to form a shirred material having a space of 8 shirrs to the lineal inch with each shirr 18 having a pitch or height of 5/16" when the shirred material is mounted upon its backing. The number of shirrs per lineal inch is called the spacing; the space between the shirrs is called the valley; the tip of the shirr is called the ridge, the extent to which the side face of one shirr overlies the adjacent side face of its neighbouring shirr when they are compressed together is called the overlap; and the length of each shirr from the base of the shirr to the ridge is called the pitch or height. The specific belt shown is one in which the shirred material is so shirred with the individual shirrs 18 partially overlapping one another so that, looking down upon the material, a portion or band 1/4" wide of each individual shirr is exposed to view when the shirred material is lying in flattened condition. The thusly shirred material is adhesively attached to the fabric backing 15 by means of a thin layer of permanently flexible, rubber-base adhesive applied to the underface of the shirred material and/or to the fabric backing. The adhesively coated shirred material is superimposed on the backing and the adhesive cured while the two are held under light pressure in close contact with one another. The adhesive, in addition to forming a thin layer 16 between the backing and the shirred material, is drawn up around the base portion of the shirred material to anchor it firmly to the backing as shown in highly exaggerated form in Figure 3. The ends of the backing are spliced diagonally to form an endless abrasive belt of the desired length. The diagonal splicing of the backing fabric obviously is not coincident with the transverse splice of the shirred material which is spliced normal to the

lengthwise direction of the belt, so that as a result there is practically no bumping of the belt during operation.

The resulting endless belt has been found
 5 highly satisfactory for the performance of many abrasive and polishing operations. An analytical study of the structural details of such a belt will readily reveal why abrasive
 10 belts when so constructed have a life of useful service far beyond that obtained with coated abrasive belts of the conventional type consisting of a single layer of abrasive grits adhesively bonded to a paper or cloth backing. Referring for example, to an endless abrasive
 15 belt of the described type 54" long and 4" wide with the individual shirrs of 5/16" pitch or height it should be noted that each individual shirr is duplex in character, i.e., composed of two folds of material. The
 20 shirrs lie at an angle of 15 deg. when compressed; about 30 deg. when uncompressed, and about 60 deg. when the shirred belt is passing over a 4" diameter pulley. The area of each shirr is therefore approximately 4" x
 25 5/16" and, taking into consideration the duplex character of the shirr, the total area in each shirr is thus twice 4" x 5/16". With 8 shirrs to the lineal inch the total number of shirrs for a belt 54" long is 432, and
 30 multiplying this by the total area of each duplex shirr, the total area of abrasive material in the belt is 1080 sq. in. By comparison, the total abrasive area for a conventional coated abrasive belt 4" x 54" is 216 sq. in. Further-
 35 more, it should not be overlooked that the abrasive strip material is charged with abrasive throughout its entire thickness so that the total number of abrasive particles available for work is many times in excess of
 40 the number of abrasive grains available in a conventional abrasive coated belt of the same size. Furthermore, the abrasive grains in a belt of the present construction undergo positional shifting in all directions during use
 45 so that the grains are constantly presenting fresh facets or cutting edges to the work with the result that each individual abrasive grain is fully utilized before its release whereas by contrast the individual abrasive grains as
 50 fixedly mounted upon an abrasive coated belt of the conventional type are firmly anchored in one immobile position and as soon as the upper cutting edge is worn off or becomes dull the belt either becomes loaded or the abra-
 55 sive grain is broken from its bond and released without performing further abrasive action. When all these factors are taken into consideration the unusually long life obtained from abrasive belts of the present invention
 60 is readily understandable.

Figure 4 depicts a modified form of abra-
 sive belt made in accordance with the present
 invention in which the shirred material, in-
 65 stead of being shirred with individual shirrs partially overlapping one another as in the

belt shown in Figure 1, is so shirred that the individual shirrs completely overlap. The resulting shirred material 19 is adhesively
 secured to the backing 20 along the alternate
 transverse fold lines along one side of the
 shirred material by means of adhesive 21 with
 70 the individual duplex shirrs 19 extending up-
 wardly from the backing to provide an abrading
 face composed of a plurality of individual
 abrasive elements which are highly flexible
 75 and mobile in character. By varying the
 pitch of the individual shirrs of the shirred
 material, or the extent to which the shirred
 material is forced together or extended when
 it is mounted upon the backing 20, (in other
 80 words, the spacing) or both, any specific type
 of abrasive or polishing action desired can
 be obtained in the ultimate article depend-
 ing upon the use or purpose to which the belt
 85 is designed.

Figure 5 shows still another modified form
 of abrasive belt in which the abrasive-bearing
 sheet material can be shirred as shown in
 Figures 1, 2 and 3 or in the form shown
 in Figure 4, but in order to provide greater
 90 lateral mobility to the individual abrasive
 elements constituting the working face of
 the belt the shirred material is slit length-
 wise of the belt by a plurality of length-
 wise slits 23 and 24, the shirred material
 95 being left unslit at intervals 25 to give
 needed stability to the belt. The unslit
 shirrs are called the tie-in shirrs. Slits 23
 are preferably staggered laterally with respect
 to slits 24 so that the abrasive action of
 100 the belt will be uniform across the belt width.

Figures 6 and 7 show an abrasive disc
 made in accordance with the present inven-
 tion and comprising a flexible backing 27 and
 an abrasive annulus 28 secured by adhesive
 105 29 to the backing. The backing can be of
 vulcanized fibre, spring steel, one or more
 plies of rubber-impregnated sisal fibre or
 other fabric or material, singly or in com-
 110 bination, providing suitable support for the
 shirred abrasive material. The abrasive
 annulus 28 is constructed of a shirred material
 folded with the individual shirrs partially
 overlapping in the same manner as the shirred
 material used for forming the abrasive belt
 115 shown in Figure 1. A narrow band or area
 of each individual shirr is exposed at the
 annular working face of the disc and as
 the individual shirrs are worn away in use
 fresh areas of each shirr are exposed for
 120 abrasive action. As in the case of the abra-
 sive belts, the pitch or height of the shirrs
 and/or the spacing or degree of overlapping
 of the shirred structure can be varied, depend-
 125 ing upon the particular abrading character-
 istics desired in the disc. The abrasive
 annulus can be composed of narrow strips of
 abrasive-included fibrous sheet material shirred
 with the shirrs fully overlapping and mounted
 130 upon the backing in a series of concentric

configurations from the periphery partially in to the arbor portion of the disc. Instead of a series of individual concentric strips of shirred material, a single strip of shirred material can be spirally mounted upon the backing.

Figure 8 depicts an abrasive belt similar to that shown in Figure 2, but in which the shirred abrasive material 30 adhesively secured to the backing 31 consists of a shirred layer of matted steel wool fibres. The layer of matted steel wool fibres is desirably impregnated with a rubber latex to assist in retaining the fibrous material in layered form of suitable thickness prior to the shirring of the layer or sheet of steel wool fibres.

However, other adhesives can be used for holding the steel wool fibres together, if desired, such as any of the various thermosetting or thermoplastic adhesives, or synthetic rubber latices or elastomers such as polychloroprene or silicone latices, glue, casein, hard soap and waxes or the like, or in fact, for some purposes no holding adhesive for the fibres need be used. Such an abrasive belt is highly satisfactory for the finishing of furniture and for other operations where conventional abrasive belts are found to load up quickly with shellac, varnish resin, and other material removed from the surface.

Figures 9 and 10 show an abrasive wheel or drum constructed of a hub 32 to which is attached by means of adhesive 34 an abrasive-included fibrous sheet material in shirred form. The shirred material 33 is secured to the hub along the alternate fold lines of the shirred material with the individual shirrs extending radially outward from the hub. If desired, particularly in drum structures in which the pitch of the shirred material is not great, the hub structure can be recovered with a layer of foam or sponge rubber or other resilient material to provide further cushioning of the shirred abrasive material which is then adhesively attached to the peripheral covering of foam or sponge rubber or the like. Abrasive wheels of this type can be subject to many modifications by changing the radial depth or pitch of the shirred material and also the slitting of the shirred material circumferentially of the wheel to provide a multitude of individual abrading elements in the form of abrasive fingers. Also, an abrasive drum embodying the various features and advantages of the present invention can be constructed by provision of an endless belt structure embodying the shirred abrasive elements of the herein described type and the belt mounted upon an expandable hub to provide an abrasive drum. Set-up wheels and like structures with replacement peripheries can be obtained, the rim or peripheral portions being readily attachable and removable by provision of suitable means for mounting on the hub or base portion.

Figure 11 is a back view of an abrasive belt fragment, showing reinforcement of the backing of the belt by means of a plurality of lengthwise filaments or strands 35 and 36 of high tensile strength material such as nylon or glass fibre cordage. As shown, the specific reinforcing strands 35 and 36 are right and left hand windings, respectively, moving outwardly from the transverse centre line of the belt to the lateral sides. It will be apparent from the manifold types of abrasive devices herein described and illustrated in the drawing that numerous other forms of abrading devices can be constructed of shirred material embodying the various features and principles herein set forth. For example, abrasive annuli or sticks can be constructed in which the shirred abrasive strip material is toroidally wrapped about an annular or bar-shaped core member as a support to provide articles suitable for internal dressing operations, honing or the like.

Also, an abrasive device can be provided in which the shirred abrasive strip material is in the form of a plurality of narrow shirred strips, the strips being secured to the support or backing laterally of one another. In this way the shirrs form a wide abrading face composed of a multiplicity of individual small mobile abrading elements adapted in use to conform to and follow the contours of a workpiece forced thereagainst. In the case of an abrasive disc or the like a similar effect may be obtained by means of a spirally laid, narrow strip. With such a plurality of narrow abrasive strips, the abrasive content of the strips can be progressed from an abrasive material of coarse particle size at one side of the device to an abrasive material of fine particle size at the transversely opposite side of the strip.

Such a device, as described above, employing a plurality of narrow shirred strips can be formed in which the fold lines of the shirrs are disposed in a plurality of directions. For example, the individual shirred strips can be disposed at alternating acute angles to the transverse direction of the device. In this way the abrading face of the device is composed of a multiplicity of short abrasive-bearing flexible leaf-like abrading elements forming a herringbone pattern at the surface.

WHAT WE CLAIM IS:—

1. An abrasive device comprising a shirred abrasive strip material mounted upon a support or backing, said shirred abrasive strip material being adhesively secured to the backing along alternate fold lines of the shirred strip material with the individual shirrs thereof at least partially overlapping one another in the direction of movement of the device during use and forming a plurality of separate abrading elements constituting the working face of the abrasive device.

2. An abrasive device according to Claim 1 in which said shirred abrasive strip material is an abrasive-included fibrous sheet material.
- 5 3. An abrasive device according to Claim 2 in which the abrasive of the abrasive-included fibrous sheet material is tripoli powder.
4. An abrasive device according to Claim 1 in which said shirred abrasive strip material is a shirred layer of steel wool.
- 10 5. An abrasive device according to Claim 4 in which the steel wool is impregnated with a resilient binder.
6. An abrasive device according to Claim 5 in which the resilient binder is a rubber latex.
7. An abrasive device according to any preceding Claim in which the individual shirrs of the abrasive strip material are uncombined and extend from said support to provide a plurality of small individual, mobile abrading elements constituting the working face of said device.
- 20 8. An abrasive device according to any preceding claim in which the shirred abrasive strip material is in the form of a plurality of narrow shirred strips, the strips being secured to the support laterally of one another whereby the shirrs thereof form a wide abrading face composed of a multiplicity of individual, small mobile abrading elements adapted in use to conform to and follow the contours of a workpiece forced there-against.
- 30 9. An abrasive device according to any of claims 1 to 8 in which the shirred abrasive strip material is in the form of a spirally laid, narrow strip.
10. An abrasive device according to claim 9, in which the strip is attached along alternate fold lines on one face of the strip whereby the individual shirrs thereof form small double-leaved abrading elements extending outwardly from the supporting element.
- 40 11. An abrasive device according to any of claims 8 to 10, in which the abrasive content of the abrasive strips progresses from an abrasive material of coarse particle size at one side of the device to an abrasive material of fine particle size at the trans-
versely opposite side of the device.
- 50 12. An abrasive device according to any of claims 8 to 11, in which the strips are secured to the supporting member along alternate fold lines of the shirrs, whereby the individual shirrs of the shirred strip material extend from the supporting member and are freely movable over most of the area of the shirrs.
- 60 13. An abrasive device according to any of claims 8 to 12, in which the fold lines of the shirrs are disposed in a plurality of directions.
14. An abrasive device according to claim 13, in which the individual shirred strips secured to the supporting member are dis-
posed at alternating acute angles to the trans-
verse direction of the device whereby the
abrading face of the device is composed of
a multiplicity of short abrasive-bearing
flexible leaf-like abrading elements forming
a herringbone pattern at the surface.
- 70 15. An abrasive device according to any preceding claim in which the device is in the form of an endless belt, having a flexible backing to which the shirred abrasive strip material is secured.
16. An abrasive device according to claim 15, in which the individual shirrs of the strip material partially overlap one another, the shirred strip material being secured to the backing along alternate fold lines of the shirred strip material.
- 80 17. An abrasive device according to claim 15 or 16, in which the shirred abrasive strip material has a single strip width laterally co-extensive with said backing.
18. An abrasive device according to claim 17, in which the shirred abrasive strip material is slit lengthwise of said belt to divide each of the shirrs thereof into a plurality of individual abrading elements transversely of said belt.
- 90 19. An abrasive device according to claim 18, in which the slits in said strip material at one lengthwise stretch of the belt are staggered laterally in relation to the slits in the strip material at adjacent lengthwise stretches of the belt.
20. An abrasive device according to any of claims 15 to 19, in which the device is detachably mounted around the periphery of a hub member so as to form a set-up wheel.
- 100 21. An abrasive device according to claim 30, in which the hub member is expand-
able.
22. An abrasive device according to any of claims 1 to 14, in which the device is in the form of an abrasive disc comprising a flexible backing member, the shirred abra-
sive strip material being secured to the
backing.
- 110 23. An abrasive device according to claim 20, in which the shirred abrasive strip material is secured to the backing along alternate fold lines of the shirred strip material.
24. An abrasive device according to any of claims 1 to 14, in which the device is in the form of an abrasive wheel comprising a hub member, the shirred abrasive strip material being mounted thereon, said strip material being secured to the hub member at alternate fold lines of the strip whereby each of the shirrs of said strip forms a
flexible double-leaved abrading element.
- 120 25. An abrading device according to claim 24, wherein each of the shirrs of the abra-
sive strip is slit in from the periphery of
- 125

said wheel to form a plurality of individual abrading elements transversely of the wheel.

26. An abrasive device according to any of claims 1 to 14, in which the support or
5 backing is a core member on which the shirred abrasive strip material is toroidally wound.

27. An abrasive device according to any

preceding claim, in which the strip material is secured by a rubber-base adhesive.

28. An abrasive device substantially as 10 hereinbefore described with reference to Figs. 1 to 3, or Fig. 4, or Fig. 5, or Figs. 6 and 7 or Figs. 8 or Figs. 9 and 10.

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